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Australia mining boom and Dutch Disease: analysis using VAR method

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Abstract

Australia has experienced several episodes of mining boom in its economy. Studies on the impact of mining booms on the economic growth and development indicates that, mining boom either through rise in commodity prices or mining investment tend to result in appreciation of currency thus harming the manufacturing and other sectors in the economy, while the overall gross domestic product increases and this is termed Dutch Disease. The aim of this work is to investigate the dynamic relationship between mining GDP, manufacturing GDP, service GDP and exchange-rate using vector autoregressive (VAR) approach consisting of impulse response function (IRF), variance decomposition (VDC) and VAR Granger Causality . Using annual data for the sample period 1975-2013 sourced from Australian Bureau of Statistics, we find mixed evidence presented by the IRF, while the VDC reveal that mining sector have an impact on the exchange rate. The results also suggest that mining GDP contribute to the variation in the service sector. VAR Granger causality suggest that exchange rate granger cause manufacturing and that mining granger cause services sector. The study concludes by suggesting promotion of international competitiveness in other sectors such as manufacturing and tourism, to also promote innovation and technical know-how to help avoid Dutch Disease effects that can turn mining boom into a resource curse.

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Keywords: Mining boom; Australia; Dutch Disease; VAR analysis

1. Introduction

Australia has a history of mining booms dating back to 1850s gold rush to the current episode of both mineral and

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energy boom (Battellino, 2010). The country's mining industry grew by 85% (gross value added) and this was measured in Australian dollar from 2005 to 2011 (Corden, 2012). The core of the boom is centred on large expansion in the iron, coal and gas industries, which grew by 100% in value reflecting to a significant extent increases in prices. The boom has been to a great extent fuelled by demand for resources by emerging developing economies such as China and India. This resulted in the value of Australia's GDP growth by 41% from year 2005 to 2011. Therefore, minerals and energy boom in Australia has been prime because of this considerable growth (Gregory and Sheehan, 2011: Gregory, 2012).

Increased capital inflow caused by the rapid rise of commodity prices strengthened Australian dollar. According to TRA (2012b) Australia's strong ties to Asia's demand for resources have played a key role in the long term rise of Australian dollar against other leading currencies, which reached historic records in mid-2012. (Corden and Neary, 1982; Gregory, 1976) point out that increase in mineral exports lead to shrinking of other tradable goods and services and this is dubbed as Dutch Disease. This hypothesis was coined in the 1970's following contraction of manufacturing sector after the discovery of natural gas deposits in Netherlands. The concern is that resource export boom leads to a rise in real income in the country which largely accrue to the service sector while negatively affecting rest of the economy. Similar concerns are raised for Australia as resource-rich economy. Corden (2012) argue that, mining exports of Australia grow at the cost of part of agriculture, manufacturing sector and international education. Moreover, output and employment in the construction industry have grown reflecting strong demand for mining-related infrastructure, also there have been a shift in the composition of the manufacturing industry towards mining-related manufacturing and away from import-competing manufacture (Connolly and Orsmond 2011). These works highlight that commodity exports boom tend to result in appreciation of real exchange rate, thus weakening the performance of other sectors in the economy such as manufacturing.

We contribute to this literature by examining the dynamic relationship between mining sector, manufacturing sector, service sector and exchange rate. In our study, mining GDP is a proxy for mineral boom and manufacturing GDP and service GDP are used as proxies for each sector respectively. Our main focus is to test the Dutch Disease hypothesis by examining the effect of mining sector boom into manufacturing sector, service sector and exchange-rate. To examine this relationship, we used unrestricted vector autoregressive model consisting of impulse response function (IRF), Variance Decomposition (VDC) and VAR Granger causality.

2. Econometric Methodology

2.1. Data

The time series data for the analysis were drawn from Australian Bureau of Statistics and covers annual data from 1975 to 2013. The variables examined include, mining GDP, manufacturing GDP, service GDP and exchange rate (Figure 1). Manufacturing sector is an aggregate of food, beverages and tobacco products, textiles and clothes, wood and paper products, petroleum, coal chemical and rubber, non-metallic mineral products, meat products, machinery and equipment GDP. Financial and insurance, transport, trade, general government and social and personal services aggregate GDP are used as proxy for the service sector and mining sector is an aggregate of exploration and mining support services, coal, oil and gas extraction and iron ore mining GDP. All these variables are measured in chain volume measures in Australian dollar and Australian dollar against US dollar exchange rate has been used in the analysis.

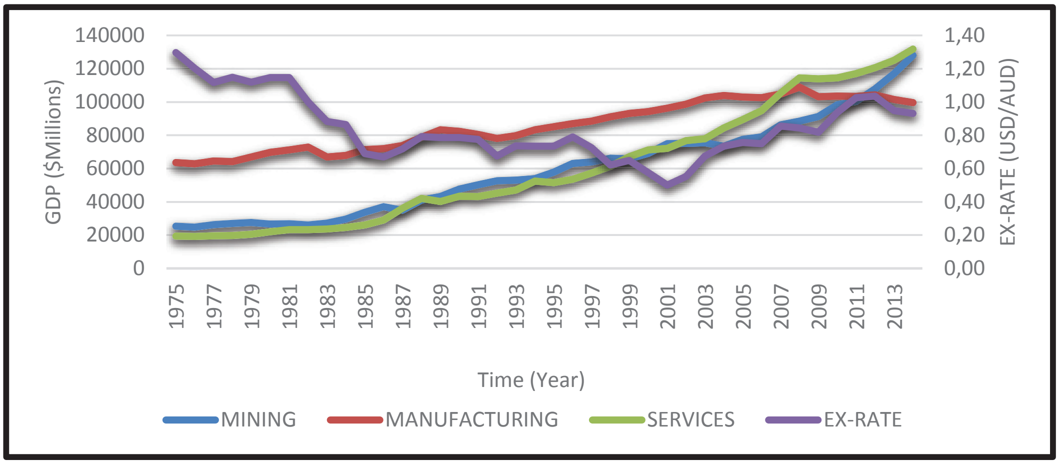


Fig. 1. The trajectory of mining GDP, manufacturing GDP, service GDP and exchange-rate from 1975-2013.
Source: Australia Bureau of Statistics (ABS), 2013

2.2. Methodology

Dutch disease theory shed light into which variables may be important in testing for the disease. Little insight is given into the structure and dynamics of the adjustments of the variables. As noted by Hutchison (1990, 1994), the rate of occurrence of deindustrialisation vary between economies based on underlying structural parameters. We therefore applied VAR approach to examine the relationship between mining, manufacturing, services and exchange-rate. The VAR approach present different methods for assessing whether the tested relationship actually exists and these includes, Impulse Response Functions (IRFs) and Variance Decompositions (VDCs) and VAR Granger causality (Lutkepohl 2006; Canova, 1995). VAR approach can be expressed as:

$$Z_t = \alpha + \sum_{j=1}^{p} \pi_j Z_{t-j} + \sum_{j=0}^{m} \varphi_t X_{t-j} + \delta t + \epsilon_t$$

Where Z_t is a vector of k endogenous variables, π_i is a matrix of k autoregressive coefficients at lag i, X_t is a vector of q exogenous variables and φ_t is a matrix of q coefficients on the exogenous variables. The error term, e_t, is assumed to contain no serial correlation and have a covariance matrix.

Cholesky decomposition sequence order is used to arrange vectors of endogenous variables. The variables that appear first are considered more exogenous while those appearing last are considered endogenous. Therefore, mining GDP is the most exogenous because the global market determine the price hence the production. Mining GDP is then followed by exchange rate, manufacturing GDP and services GDP.

2.2.1. Test of stationarity

Time series properties of the variables used for the estimation are first analysed. The purpose of this procedure is to ascertain the appropriateness of the specification and to determine the underlying properties of the data. In order to check the stationarity properties of the variables Augmented Dickey and Fuller (ADF) (1979) and Phillips and Perron (PP) (1988) were used. This was done to avoid misleading results that may be caused by estimation of econometric model based on non-stationary time-series.

2.2.2. Cointegrating test

Long-term relationship and short-term relationship was tested among variables using Johansen (1988) cointegration test, consisting of trace and max-Eigen value statistics tests. Cointegration suggests that two or more series may be linked to form a long-run equilibrium relationship despite the individual series having stochastic trend.

2.3. Granger Causality test

To determine whether changes in one variable are a cause of changes in another Granger Causality test is used. Granger (1969) posits that a variable causes change in another variable if past and present values of the former variable helps predict the latter variable. We used VAR Granger Causality test to examine causation among the concerned variables.

3. Empirical Results

3.1. Unit root tests

It is a precondition in time series analysis to examine the time series properties before any further analysis. The stationarity results for log levels of mining GDP (LNMINING), exchange-rate (LNEX-RATE), manufacturing GDP (LNMAN) and service GDP (LNSERV) are presented in Table 1. The results indicate that all the variables are stationary in their first difference and this is technically known as integrate of order. All the variables are integrate of the same order therefore suitable to perform cointegrating test.

Table 1. Results of unit root test.

	ADF(level)	ADF (1^{st} difference)	PP(level)	PP (1^{st} difference)	Order of integration
LNSERV	0.9361	0.0003***	0.9315	0.0004***	I(1)
LNMAN	0.5865	0.0001***	0.5458	0.0002***	I (1)
LEX_RATE	0.2515	0.0003***	0.2328	0.0003***	I (1)
LNMINING	0.9882	0.0000***	0.9887	0.0000***	I (1)

***Indicate rejection of the null hypothesis of non-stationary of the variables at 5% significance level.
Source: author's computation based on ABS data

3.2. Cointegration tests

The trace statistics test for cointegration indicate that there is no long-run relationship between the variables in the system, while max-Eigen value test results reveal that there is one long-run relationship among variables. According to Toda (1994) trace results in a case of a small number of samples is better, therefore we used trace results of no cointegration (see Table 2 and 3).

Table 2: Results of trace statistic test.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability***
None	0.539	46.5	47.9	0.0673
At most 1	0.284	18.6	29.8	0.524
At most 2	0.137	6.56	15.5	0.630
At most 3	0.0336	1.23	3.84	0.267

Trace test indicates no cointegration at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: author's computation based on ABS data

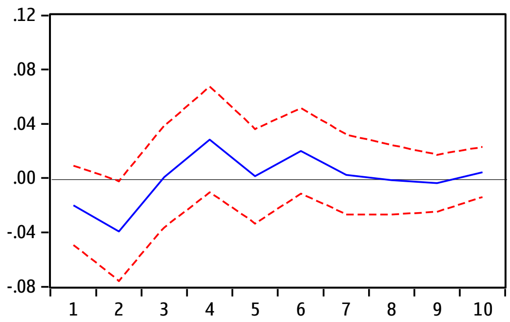
Table 3. Results of max-eigenvalue test.

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Probability***
None*	0.539	27.9	27.6	0.0458
At most 1	0.284	12.0	21.1	0.546
At most 2	0.137	5.32	14.3	0.701
At most 3	0.0336	1.23	3.84	0.267

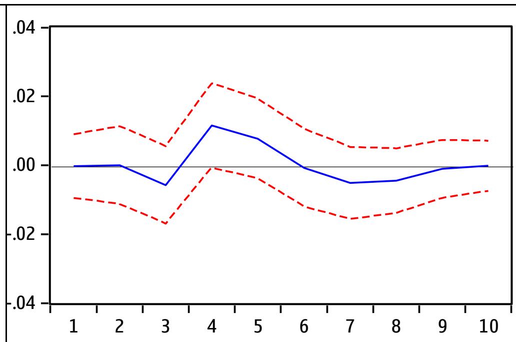
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: author's computation based on ABS data

3.3. Impulse Response Functions

Figure 2 show the impulse response functions (IRFs) of exchange-rate, manufacturing GDP and service GDP. They show the response of a particular variable to one standard deviation shock on each of the variables in the system. The response of exchange-rate to shocks in mining GDP is negative in the first quarter and second quarter, and positive on the third to seventh quarter indicating appreciation of Australian dollar and then the shock got stabilised. Manufacturing output responded negatively on the first to third quarter, positively on the fourth to fifth quarter and negative again on the sixth to tenth quarter. While the service GDP responded negatively to the mining shock on the first to second quarter and positively on the third to the fifth quarter and the pattern continues until the tenth quarter. The manufacturing GDP responded positively to exchange-rate on the first quarter to second quarter and negatively from the second to fifth quarter and the shock stabilises.



Response of exchange-rate to mining shock



Response of manufacturing GDP to mining shock

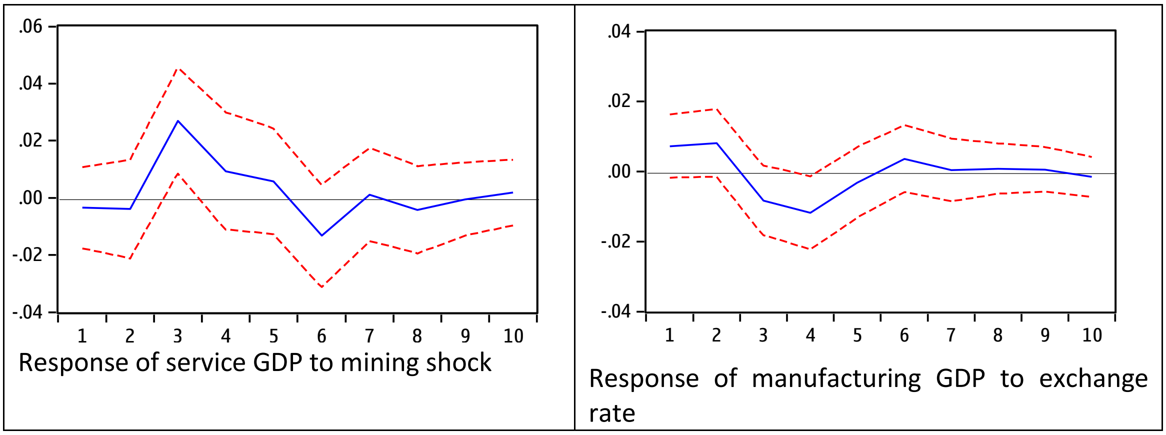


Fig. 2. Results of impulse response function.
Source: author's computation based on ABS data.

3.4. Variance Decomposition

Figure 3 present variance decomposition results, showing the proportion of the forecast error variance for each variable that is attributable to its own shocks and shocks in other variables in the system. The main finding is that, for all the variables own shocks constitute the predominant source of variations. Mining shock explain 23.6% of variation in exchange-rate and 29.5% of variation in service GDP by tenth quarter. While on the other hand variations in manufacturing GDP are explained by the exchange-rate followed by 24.8% and 14.3% of mining shock respectively at the end of tenth quarter.

Table 4. Results of variance decomposition.

Period	Variance decomposition of ΔMIN				Variance decomposition of ΔEX_RATE			
	ΔMIN	ΔEX_RATE	ΔMANUF	ΔSERV	ΔMIN	ΔEX_RATE	ΔMANUF	ΔSERV
1	100	0	0	0	5.2	94.8	0	0
2	80.16	4.26	12.14	3.44	19.47	78.24	1.05	1.24
3	72.88	6.48	13.08	7.56	19.08	78.17	1.26	1.49
4	70.08	6.82	12.87	10.22	22.43	65.61	4.33	7.63
5	68.02	7.72	14.4	9.86	21.81	63.84	5.6	8.74
6	67.05	8.61	14.54	9.8	24.14	61.79	5.47	8.6
7	67.19	8.55	14.37	9.89	23.88	61.29	5.89	8.94
8	66.95	8.52	14.49	10.04	23.5	61.58	5.99	8.92
9	66.8	8.51	14.49	10.21	23.56	61.44	6.04	8.95
10	66.82	8.68	14.34	10.16	23.64	61.36	6.02	8.98

Period	Variance decomposition of ΔMANUF				Variance decomposition of ΔSERV			
	ΔMIN	ΔEX_RATE	ΔMANUF	ΔSERV	ΔMIN	ΔEX_RATE	ΔMANUF	ΔSERV
1	0.0067	6.85	93.15	0	0.67	6.29	5.07	87.97
2	0.006	13.85	83.31	2.84	1.36	6.57	7.45	84.62
3	3.37	19.22	73.52	3.89	25.29	9.54	5.8	59.37
4	13.2	26.18	57.35	3.27	26.56	10.43	6.99	56.01

5	16.9	25.36	54.18	3.56	26.36	10.69	9.4	53.53
6	16.66	25.9	53.23	4.21	29.91	10.37	9.06	50.66
7	18.1	25.17	51.81	4.91	29.46	10.84	9.85	49.85
8	19.15	24.71	51.1	5.03	29.71	11.03	9.79	49.46
9	19.2	24.69	51.09	5.03	29.59	11.07	9.89	49.45
10	19.14	24.78	51.03	5.06	29.53	11.27	9.95	49.23

3.5. VAR Granger Causality

It is important to examine causality relationship among the four variables. Table 5 shows the estimated results of VAR Granger Causality. The results indicate unidirectional causality from manufacturing to mining. However, with exchange rate as the dependent variable, there is no causality running from any of the variables to exchange rate. On the other hand, with manufacturing as the dependent variable, exchange rate granger cause manufacturing while services is granger caused by mining.

Table 5. Results of VAR Granger Causality.

Dependent variable	ΔMIN	ΔEX_RATE	ΔMANUF	ΔSERV	Joint significance
ΔMIN	-	4.46 (0.216)	8.42(0.0382)*	6.94 (0.0739)	13.66 (0.135)
ΔEX_RATE	6.29 (0.0980)	-	5.71 (0.127)	6.17 (0.103)	13.17 (0.155)
ΔMANUF	1.13 (0.770)	9.30 (0.0255)*	-	1.58 (0.663)	16.163 (0.0635)
ΔSERV	11.19(0.0107)*	5.17(0.159)	0.375 (0.945)	-	18.67 (0.0281)

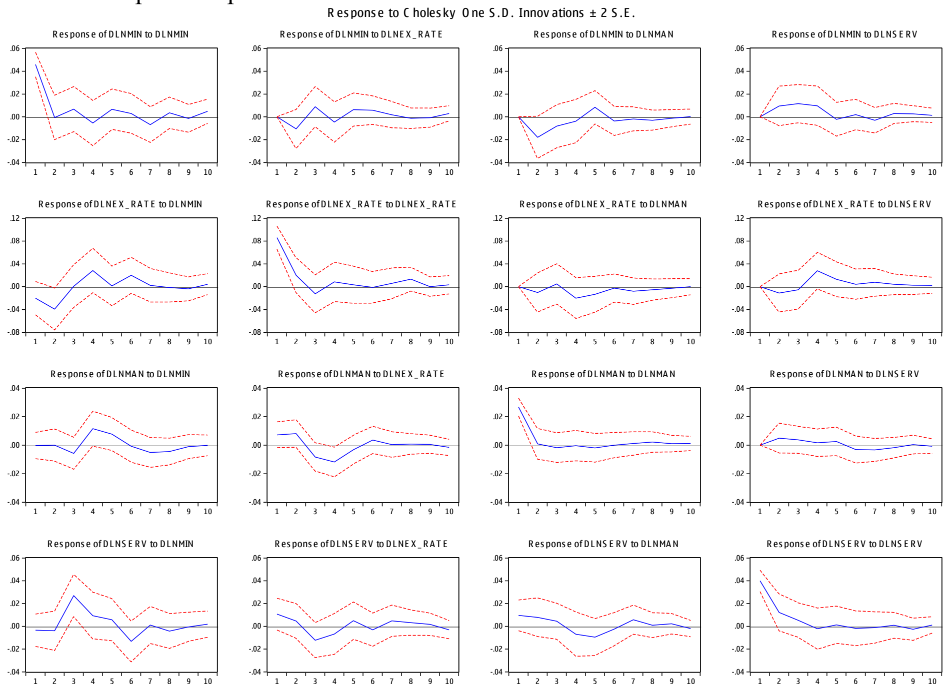
(1) * indicates significance at 5% level.
(2) Numbers in the parentheses are probability values.

4. Conclusion

This study investigates the empirical validity of Dutch Disease effect in the economy of Australia. We provide here, a contribution on the subject by examining the relationship between mining GDP, manufacturing GDP, service GDP and exchange-rate. Unrestricted Vector autoregressive (VAR) model was used for the estimation. The model is particularly useful for showing the effects of shocks on the adjustment path of the variable and to identify the contribution of each type of shock to the forecast error variance. The impulse response function results show patterns of variation among the variables. Variance decomposition indicate relationship among the variables with 23.6% of exchange-rate explained by the mining shocks and on the other hand exchange rate explain 24.8% of manufacturing. This relationship suggest the importance of sound policies to contain exchange rate in order to avoid harming manufacturing sector. Moreover, mining shock explain 29.5% variation of service GDP indicating that mining industry stimulate service industry in Australia. VAR Granger causality complement variance decomposition by suggesting that mining granger cause services sector. The results reveal an element of three speed economy in Australia. Therefore it is important for Australia to enhance sound and prudent macroeconomic policies to avoid contraction of manufacturing that might be caused by appreciation of currency due to increased commodity prices. The study concludes by suggesting promotion of international competitiveness in other sectors such as manufacturing and tourism, to also promote innovation and technical know-how to help avoid Dutch Disease effects that can turn the mining boom into a resource curse.

Appendix

1. Results of impulse response function.



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